# Thermally-driven rare events, action minimization, and reduced limits

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To estimate switching probabilities for non-gradient systems, or to estimate short-time switching probabilities even in the gradient case, it is necessary to go beyond the usual Arrhenius-law picture. The Wentzell-Freidlin theory of large deviations estimates the probability of rare events in terms of an action functional. Although initially applied to spatially uniform systems, the large deviation framework generalizes naturally to spatially *nonuniform* systems. Generically, the action minimization problem is nontrivial and must be treated numerically. One may also look for analytical reductions of the action functional in appropriate limiting regimes. In the context of the Landau-Lifshitz-Gilbert equations for instance, certain parameter regimes lead to magnetic states which are characterized by the location of boundary vortices. A simpler but related example which we will study is the sharp-interface regime of the Allen-Cahn equation.

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